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ELECTRON MICROPROBE ANALYSIS OF TOURMALINE GRAINS, MECSEK MOUNTAINS, HUNGARY

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ABSTRACT

Some outcrops of Bakonya Member of Kővágószőlős Sandstone Formation (detrital complex of the Upper Permian of Mecsek) contains a considerable amount of tourmaline. Optically these grains can be divided into different groups. In addition to different genesis of grains some of them has syntaxial rim. It is well known that tourmaline is an excellent indicator of rock types. The result of microprobe investigations of tourmaline grains were plotted on the diagrams of HENRY and GUIDOTTI (1985). The differences in composition of cores correspond to different metamorphic rocks. The grains after getting into Permian sedimentary basin had overgrown diagenetically, due to the new geochemical conditions.

INTRODUCTION

The directions of transport of Permian sedimentary complex and the source areas as well as the mineralogy of sandstone were investigated by FAZEKAS (1987). She has an opinion that the Upper Permian sandstone of Mecsek Mts. is mainly composed of eroded Paleozoic metamorphics and migmatic-granite materials of Mórágy mass in its southern and south-eastern areas. Tourmaline grains derived from the same area and are characterized by various optical properties, and these may explain their distinct origins. Electron microprobe analyses of tourmaline grains were performed so that we could obtain more exact data on their genesis.

GEOLOGICAL STRUCTURE OF WESTERN MECSEK ACCORDING TO PREVIOUS AUTHORS

The first investigation of Western Mecsek Mountains was carried out by BÖCKH (1876). VADÁSZ (1935) in his monography also wrote about this region in detail. After discovery of uranium deposits the research of this region became more intensive. Nowadays the Permian and Lower Triassic sediments are well known by the results of investigations of Ore-Mining Company (MÉV).

BARABÁS (1979), BARABÁS-STUHL (1981) and FAZEKAS (1987) gave exact descriptions of these formations.

The older parent rocks may belong to crystalline basement and carboniferous molasse.

SZEDERKÉNYI (1977), JANTSKY (1979). LELKES—FELVÁRI (1981) and ÁRKAI (1984) delt with this topic and they arrived at different conclusions. The oldest

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formation of the basement consists of Paleozoic crystalline rocks (mica-schist, gneiss, amphibolite). There are younger Silurian anchi-metamorphic schists also; which is proved by microfossils, and serpentinite subdivided into Devonian.

The origin and age of migmatic alkaline-rich granite are significant and very discussed questions.

The examined Kővágószőlős Sandstone Formation belongs to the third Permian sedimentary cycle. When the Bakonya Member was deposited, the direction of the sediment transport must have been from the west, south, south-east, so that we have to look for the source area towards these directions. The investigated area is illustrated by *Fig. 1.*

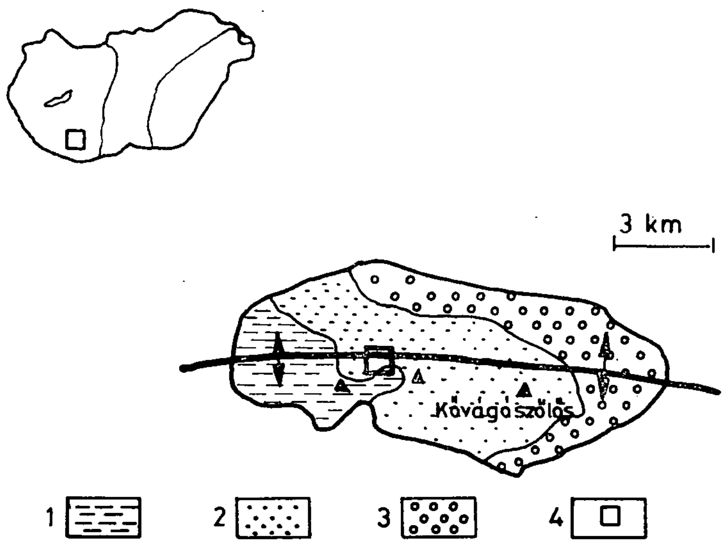


Fig. 1. Geological sketch about Kővágószőlős anticline (after BARABÁS, 1979). 1. Boda Aleurolite Formation. 2. Kővágószőlős Sandstone Formation. 3. Jakabhegy Sandstone and Conglomerate. 4. The investigated area.

OPTICAL PROPERTIES OF THE ANALYSED TOURMALINE GRAINS

The tourmaline grains examined in this work are mostly anhedral and sometimes subhedral. Their size are between 0.05 mm and 0.5 mm (see *Fig. 2* and *Fig. 3*). These tourmalines can be divided into two groups on the basis of their pleochroism. The first one is characterized by pink and black colours and the second has brown and greenish-brown tone.

The *pink tourmaline* is represented by a sole, 0.3 mm long grain, only. It shows a strong pleochroism. Passing towards the a-axis it is black and to the c-axis it is pink *(Fig. 4a, b)*.

The *greenish-brown tourmaline*'s pleochroism depends on the orientation of the segment. If the segments are paralell with the c-axis, they have a strong pleochroism; towards the c-axis it shows a pale yellow shade or it is colourless. The segments which are perpendicular to the c-axis, show usually a greenish-brown colour but they have no any visible pleochroism.

A

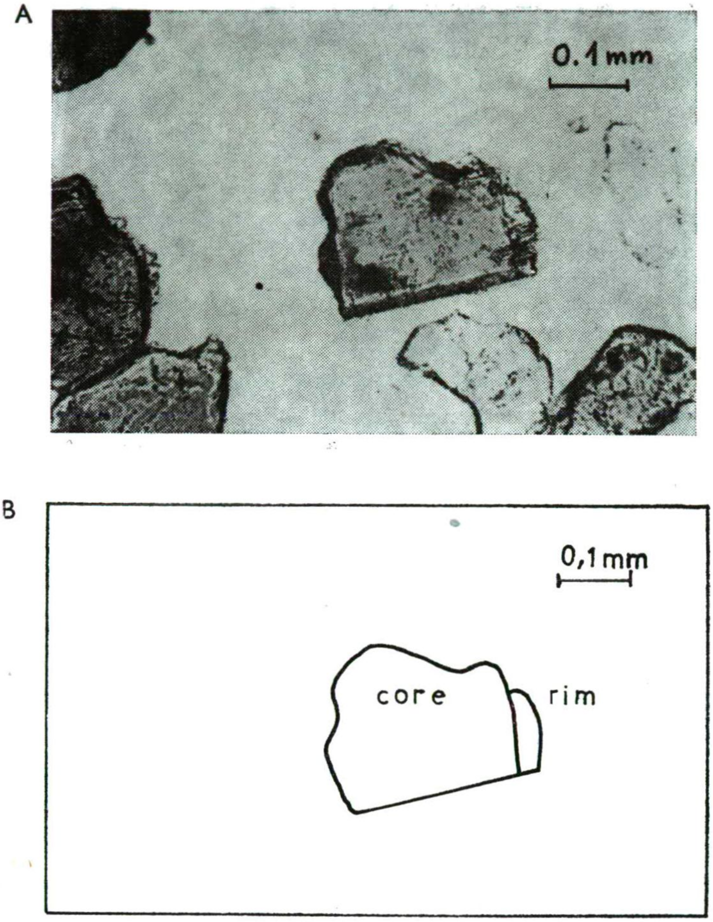


Fig. 2a, b. Pink—black coloured tourmaline grain with its blue rim.

In some grains several inclusions of garnet, rutile (?) and muscovite were recognized. In the others some zircons, ilmenites and apatites occur.

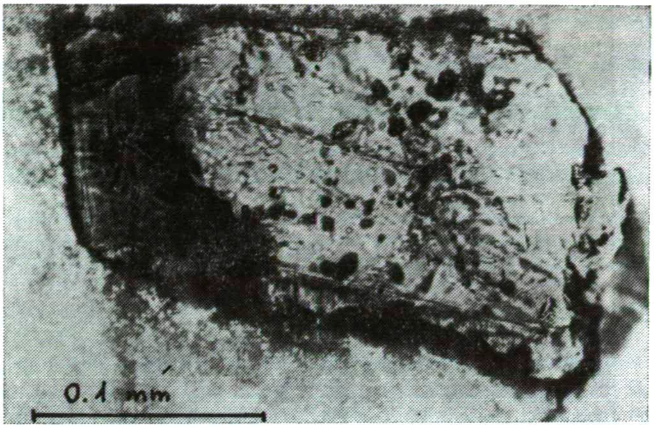
Some grains have greenish-blue syntaxial rim. The main features of these rims are the following:

— discontinous core-to-rim zoning,

— rich in inclusions, which are perpendicular to the c-axis.

— strong pleochroism: towards the a-axis the colour is greenish-blue, and towards the c-axis it is colourless.

There are some grains which have continous zoning from the core to the rim. The core is greenish-brown and the rim is greenish-blue. A small colour difference exists between the core and the rim, only.



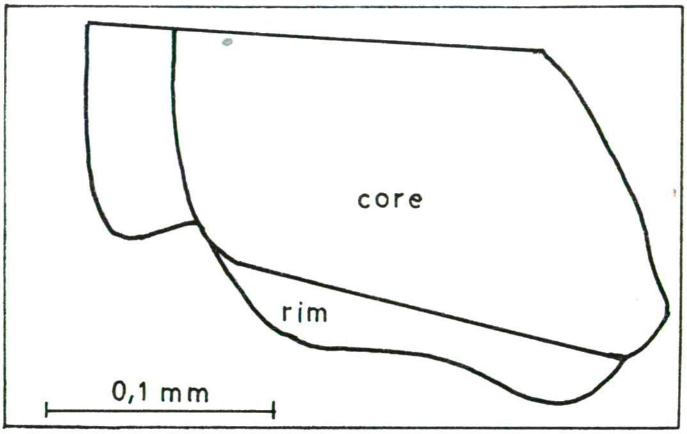


Fig. 3a, b. Greenish-brown tourmaline grain with its blue rim.

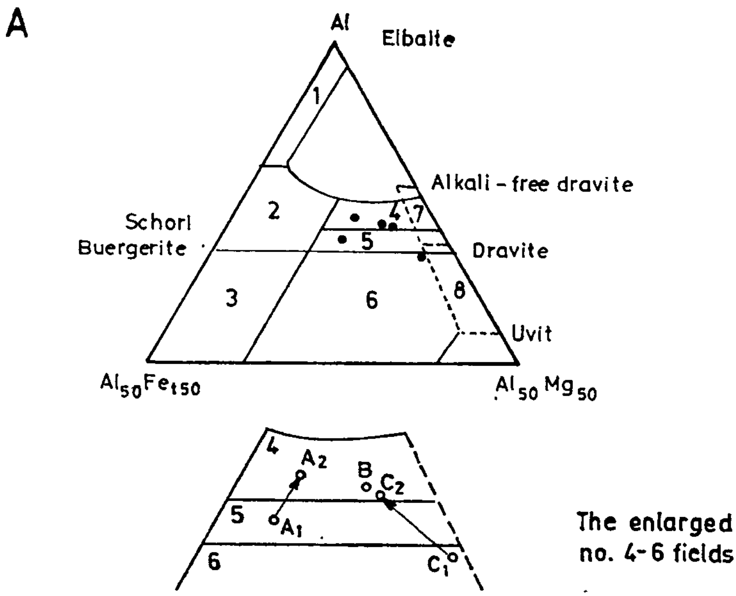
ELECTRON MICROPROBE ANALYSES OF TOURMALINE GRAINS

The tourmaline grains for the electron microprobe analyses were chosen by the favourable results of their optical examinations. Both the core as well as the rim of the grains were checked from each groups.

— It was unexpected that the composition of the other greenish-brown grain (B. in the Table 1) was similar to that of the epigenetic rims. According to its end-members it is an alkali-rich grain, which has different genesis from that of the previous ones.

In spite of our expectation we was not able to identify grains derived from the granite. Previously we supposed that the pink-black tourmaline grain may have this origin, but if it is true, its composition should have changed, during the diagenese or epigenese which caused an enrichment of the Mg, and a loss of the Fe.

These results show, that the sources of the Upper Permian detrital complex could have been various rock types exposed in the adjoining area.



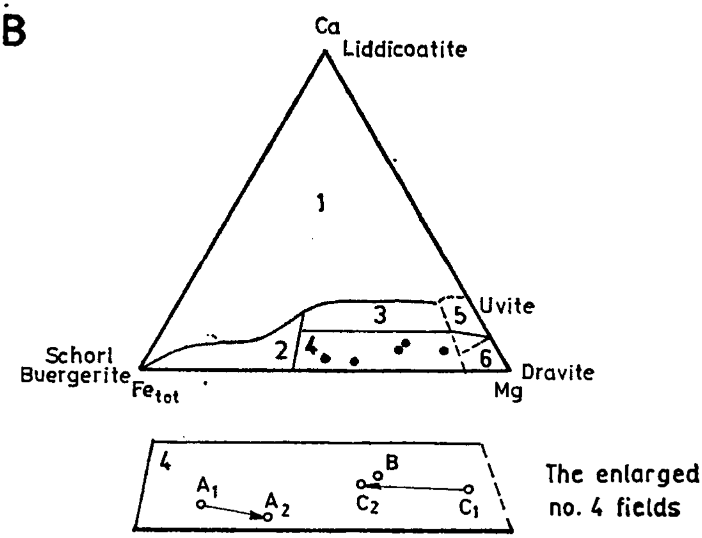


Fig. 4a. Al-Fe_{tot}-Mg diagram for tourmalines of various rocks (after HENRY and GUIDOTTI, 1985). Fields of the diagram represent the compositional ranges of tourmalines from different kind of rocks.) 1. Li-rich granitoid, pegmatite and aplite. 2. Li-poor granitoids and associated pegmatites and aplites. 3. Fe-rich quartz-tourmaline rocks (hydrotermally altered granites). 4. Metapelites and metapsammites coexisting with Al-saturating phase. 5. Metapelites and metapsammites not coexisting with Al-saturating phase. 6. Fe-rich quartz-tourmaline rocks, calcsilicate rocks and metapelites. 7. 7. Low-Ca metaultramafics, Cr-V-rich metasediments. 8. Metacarbonates and metapyroxenites. A.1 Core of the pink – black grain. A.2 Margin of the pink – black grain. B. Little greenish-brown grain (core). C.1 Core of the greenish-brown grain. C.2 Margin of the greenish-brown grain.

Fig. 4b. Ca-Fe_{tot}-Mg diagram for tourmalines of various rocks (after HENRY and GUIDOTTI, 1985). 1. Li-rich granitoid, pegmatite and aplite. 2. Li-poor granitoids and associated pegmatites and aplites. 3. Ca-rich metapelites, metapsammites and calcsilicate rocks. 4. Ca-poor metapelites, metapsammites and quartz-torumaline rocks. 5. Metacarbonates. 6. Metaultramafics. The A.1, A.2, B, C.1 and C.2 symbols are the same that of *Fig. 4a.*

TABLE 1

Electron microprobe analyses of tourmaline grains

	A.1	A.2	B	C.1	C.2
BO_3	10.0	10.0	10.0	10.0	10.0
SiO_2	37.0	38.0	37.6	36.7	37.3
TiO_2	0.31	0.04	0.82	0.65	0.77
Al_2O_3	30.5	32.8	31.4	31.2	33.3
FeO	9.8	7.8	5.1	3.5	5.6
MgO	5.7	6.0	7.7	10.5	8.0
CaO	0.32	0.14	0.86	0.82	0.87
Na_2O	2.19	1.79	2.17	2.69	2.10
total	95.82	96.57	95.65	96.06	97.94

Kation numbers

	1	2	3	4	5
B	3.000	3.000	3.000	3.000	3.000
Si	6.143	6.149	6.112	5.931	5.926
Al (T)	0.0	0.0	0.0	0.069	0.074
Al (Z)	5.970	6.000	6.000	5.875	6.000
Al (Y)	0.000	0.257	0.017	0.0	0.163
Fe	1.361	1.056	0.639	0.473	0.744
Mg	1.411	1.447	1.865	2.529	1.894
Ti	0.039	0.005	0.100	0.079	0.092
total	2.811	2.760	2.675	3.081	2.893
Ca	0.057	0.024	0.150	0.142	0.148
Na	0.705	0.562	0.684	0.843	0.467
total	0.762	0.586	0.834	0.985	0.615

Calculated on the basis of 24.5 oxigen

End-member proportions

	1	2	3	4	5
Schorl	50.8	42.0	26.0	17.0	28.3
Dravite	28.1	25.1	50.0	33.5	25.0
Uvite	6.4	2.9	16.5	16.0	16.8
Alkali-defected tourmaline	14.7	30.0	7.5	33.5	29.9

A.1, A.2, B, C.1 and C.2 symbols are the same that of Fig. 4a

The microprobe analyses were run on a JXA—50A type insrument. The accelerator voltage was 15 kV. The adsorbed electron current intensity was 30 nA and the diameter of the electronfile was 1 μm. Albite, olivine and sphene standards were used. The analyses were carried out by G.-SOLYMOS in the Department of Petrology and Geochemistry of the Loránd Eötvös University, Budapest.

Results of analyses are shown on a table and figures. The *Table 1.* represents concentrations expressed in weight perecentages and the calculated kation numbers as well as the percentages of the tourmaline end-members. The percentage of boron was calculated on the basis of structural formula. It is assumed that there are 3 boron atoms in the formula and the weight percent of B_2O_3 are as much as 10%.

The cation numbers were plotted on the Al-Fe_{tot}-Mg and Ca-Fe_{tot}-Mg triangle diagrams *(Fig. 4a, b)*. These diagrams show relationship between the various rocktypes and the composition of tourmaline grains derived from these rocks. We have to note that the fields of the diagrams may overlap each other.

CONCLUSIONS

The following conclusions can be reached from the results of the analyses:

— According to the triangle diagrams the tourmaline grains having a pink-black pleochroism (A.1 in the Table 1) may be derived from metapelites or metapsammites.

— The origin of the greenish-brown grain (C.1 in the Table 1) is difficult to explain, because the region no. 6 of the Al-Fe_{tot}-Mg diagram represents three different types of the rocks. In spite of this uncertainity, we can suppose that it comes from another type medium-grade metamorphic schist.

— These grains having different origin and arriving to the sedimentary basin after the burrying they had overgrown diagenetically and have produced a blue margin. Unfortunately there is no region for epigenetic tourmalines on HENRY and GUIDOTTI's (1985) diagram. Improvement of this method needs further investigations.

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